Introduction to Electronics:

Resistance Is Futile

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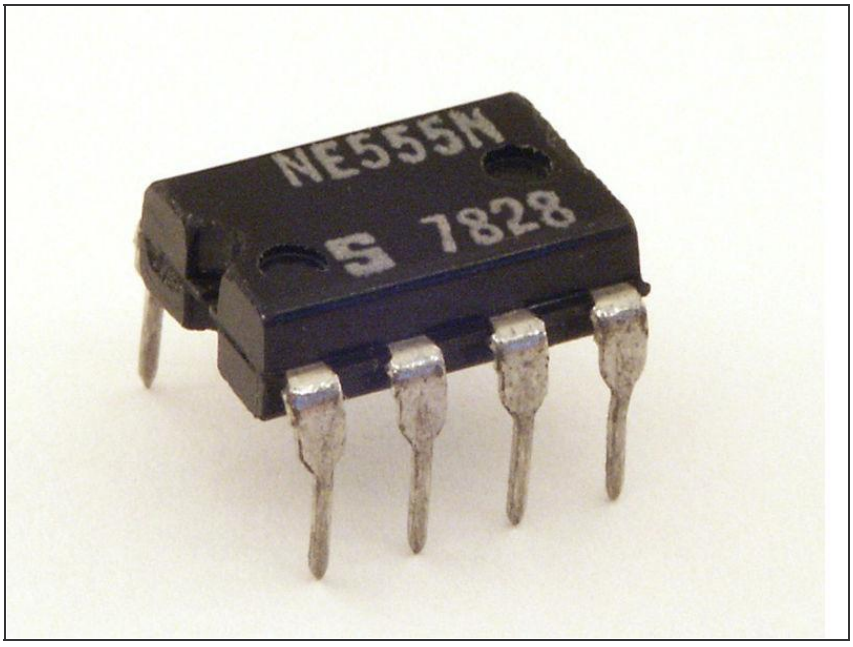
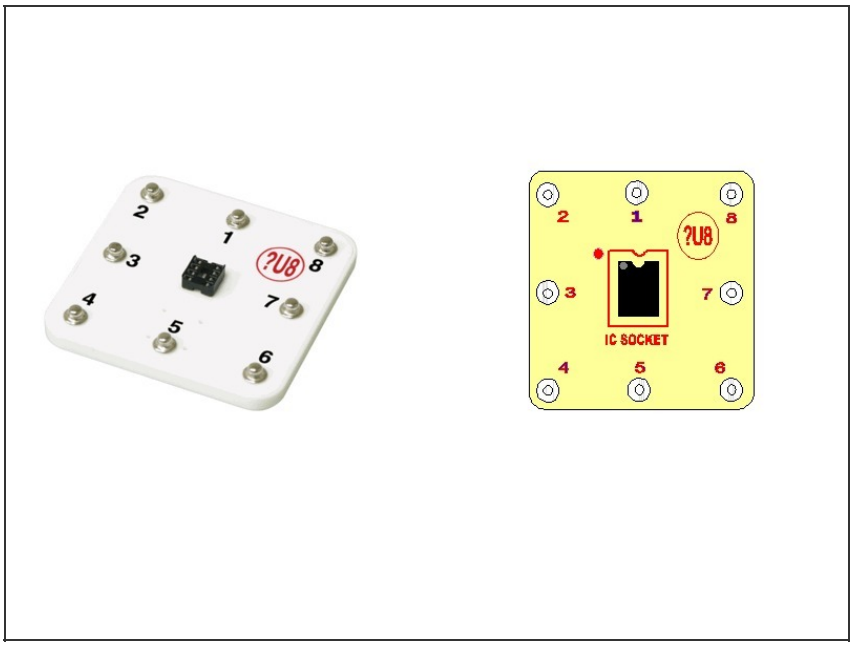
Step 1 — Introduction to Electronics: The 555 Timer Integrated Circuit (IC)



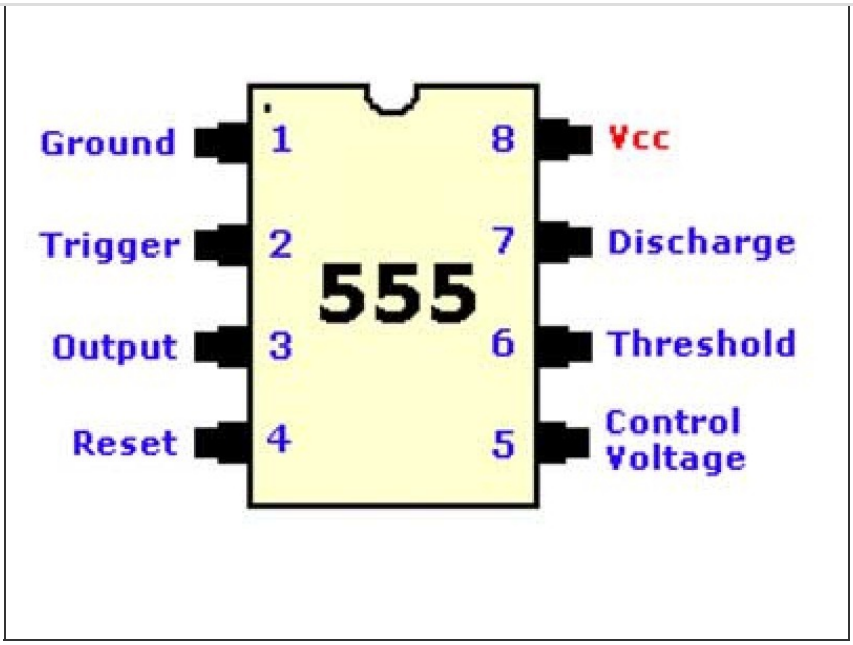
- The 555 Timer IC was introduced by a company called Signetics (later bought out by Philips) in 1972 and was designed by Hans R. Camenzind in 1971.
- The 555 chip has 25 transistors, 15 resistors and 2 diodes in an 8 pin DIP (Dual In-line Package) and looks like a square bug with eight legs.
- It has a notch at the top and Pin 1 is in the top left corner.
- Picture source

Step 2



- Insert the 555 timer chip into the Snap Circuits Eight-Pin IC Socket block (?U8). Make sure that the notch in the top of the 555 timer chip is aligned with the diagram of the chip pictured on the IC socket block.

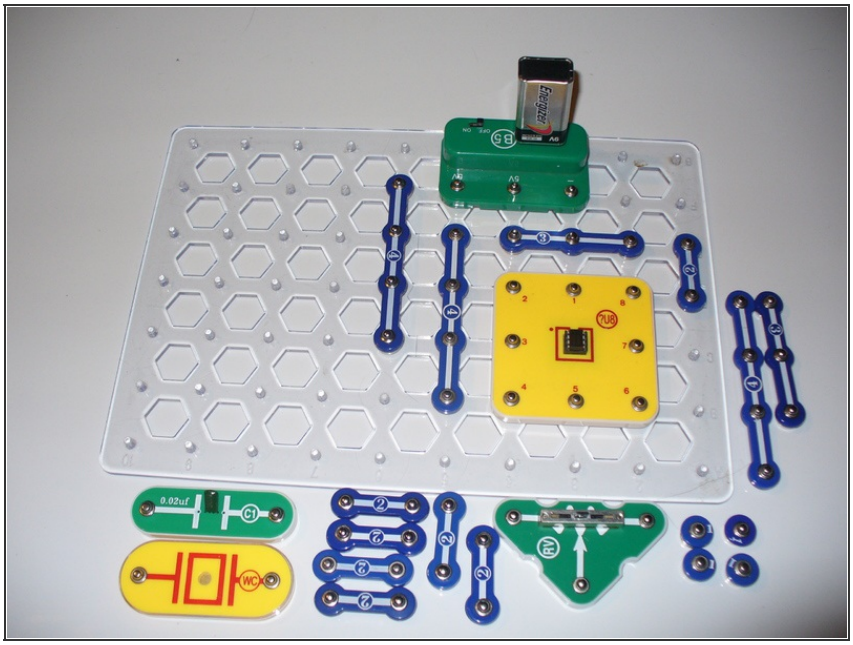
Step 3



- Pin 1 is ground. It is connected to the negative side of your battery or power supply along with any other components in your circuit connected to ground.
- Pin 2 is the Trigger pin. It will be connected to ground and thus switches on pins 3 and 7.
- Pin 3 is the Output pin. In this circuit it outputs a square wave signal that can be heard on a speaker.
- Pin 4 is the Reset pin. It is not used in this circuit.
- Pin 5 is the Control pin. It is not used in this circuit.
- Pin 6 is the Threshold pin. The capacitor that we will connect to the 555 will charge up and when it reaches about 2/3 Vcc (voltage from the battery), this is detected by the Threshold pin. This will end the timing interval and send 0v to the Output pin 3 (switch it off).
- Pin 7 is the Discharge pin. It is also switched off by the Threshold pin 6. When switched off, it cuts the power to the capacitor causing it to discharge. Pin 7 also controls timing and is connected to the 50K ohm Variable Resistor RV. Moving the slider on RV changes the resistance thus changing the timing and the pitch heard on the speaker.
- Pin 8 is connected to the positive

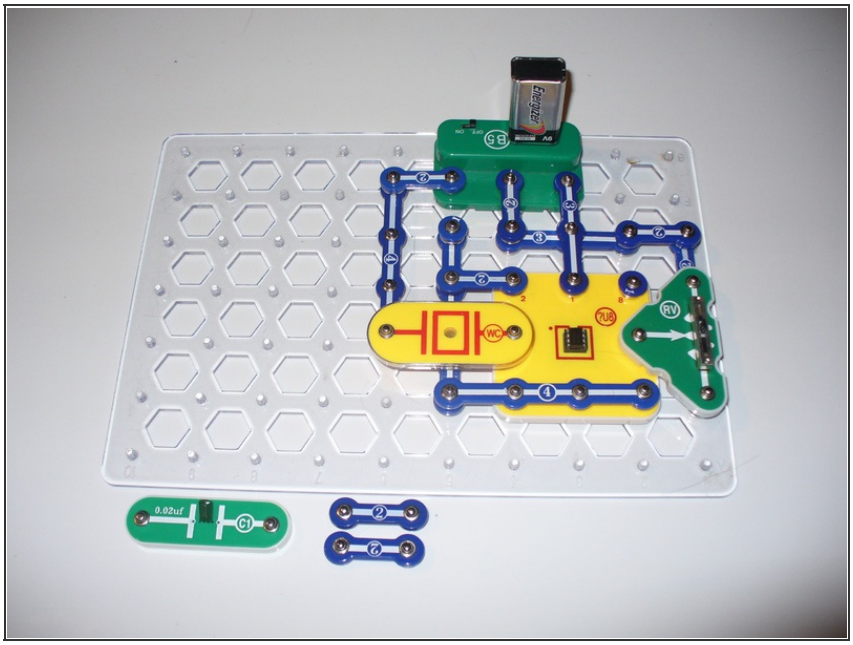
side of your battery or power along with any other components in your circuit connected to positive.

Step 4



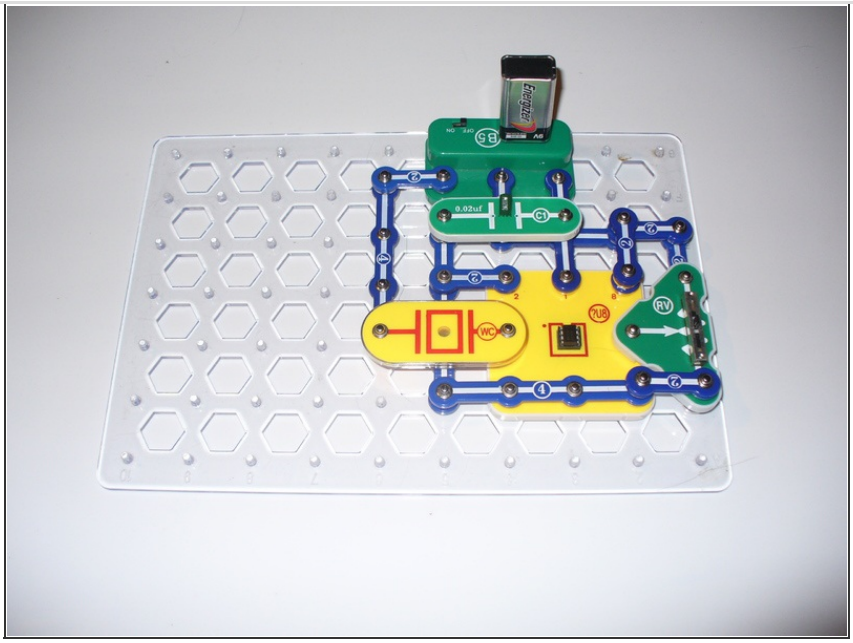
- Add the Snap Circuits blocks to the base grid as demonstrated in the picture.

Step 5



- Add the Snap Circuits blocks to the base grid as demonstrated in the picture.

Step 6

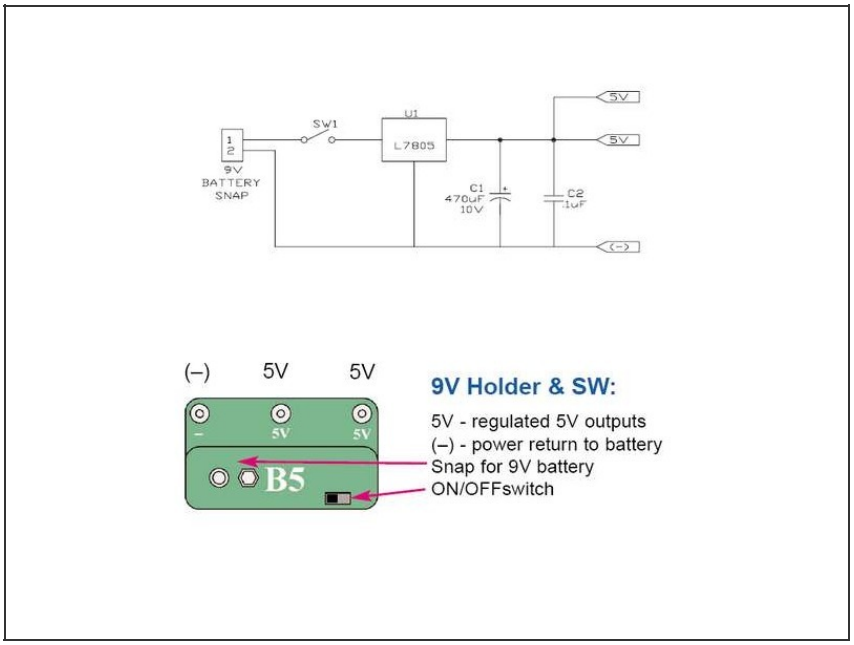


- Once you complete the circuit, switch on the 9 Volt Battery Holder (B5). You will hear a tone from the Whistle Chip. Move the slider on the Variable Resistor (RV) and you will hear the tone rise and lower in pitch depending on which way you move the slider.
- The 555 chip is in "astable mode" which means that Pin 3 is sending a continuous stream of pulses called a square wave signal to the piezoelectric speaker (WC) that you hear as a tone. The square wave signal is caused by the charging and discharging of the capacitor. When you switch on the power:
  - Step 1. The capacitor charges up. When the charge in the capacitor reaches 2/3 Voltage, this is detected by pin 6, the Threshold pin.
  - Step 2. The Threshold pin 6 switches off the Output pin 3 and pin 7, the Discharge pin.
  - Step 3. When the Discharge pin 7 is switched off this cuts the power to the capacitor which causes it to discharge. When the discharging capacitor reaches 1/3 Vcc, this is detected by the Trigger pin 2.
  - Step 4. The Trigger pin 2 sends voltage from the battery to pin 3

(the Output pin) and same voltage to pin 7 (the Discharge pin) which causes the capacitor to charge up (go back to step 1).

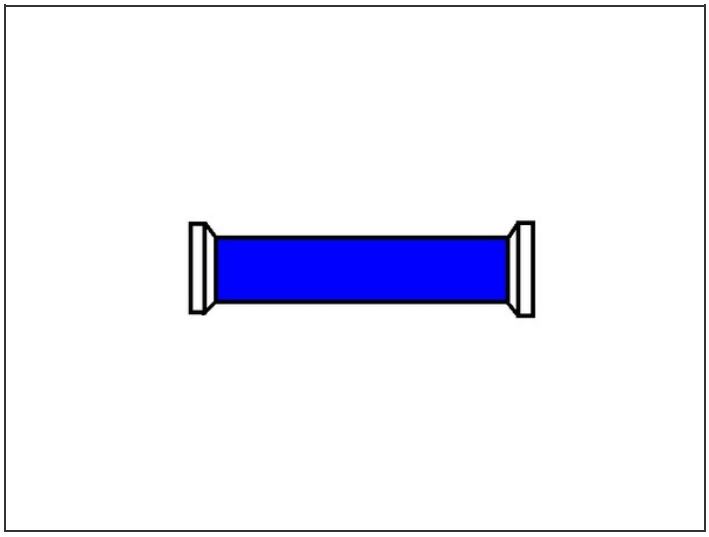
- This process repeats creating the square wave signal and you hear that signal from the speaker as a tone.
- When you move the slider on the Variable Resistor (RV) this changes the resistance of the circuit. Since the Variable resistor is connected to pin 7, changing the resistance controls the timing of how often the capacitor charges and discharges which changes the pitch you hear from the speaker.

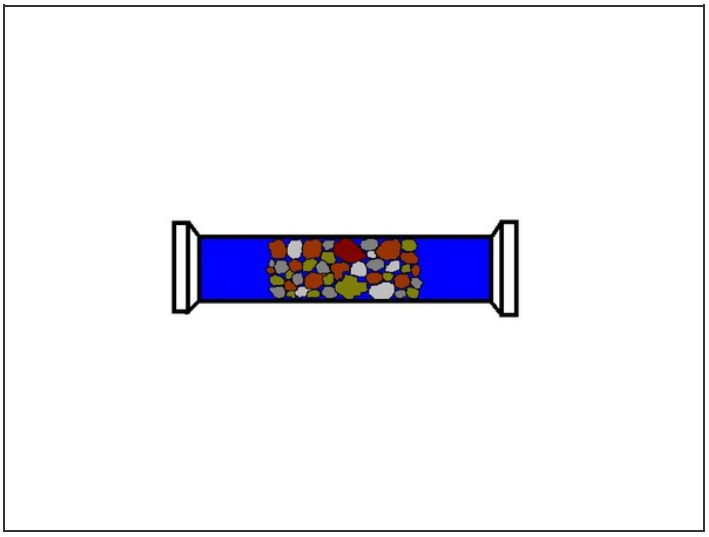
Step 7



- To power the 555, you can use the Snap Circuits B5 block (it is also called a 9 volt Holder and Switch). The advantage to using this block is that you can connect a standard 9 volt battery to the block and it will deliver a reliable 5 volts to the 555 through the L7805 voltage regulator circuit (see circuit schematic).
- The B5 also has two 5 volt outputs--one to power the 555 circuit and one that you can use to power another device.

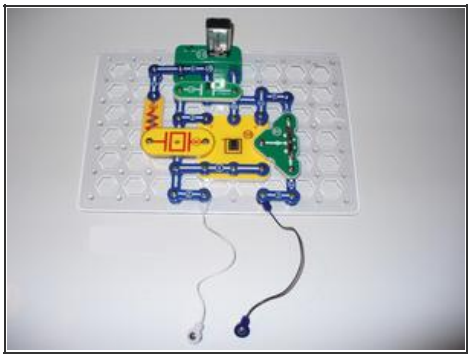
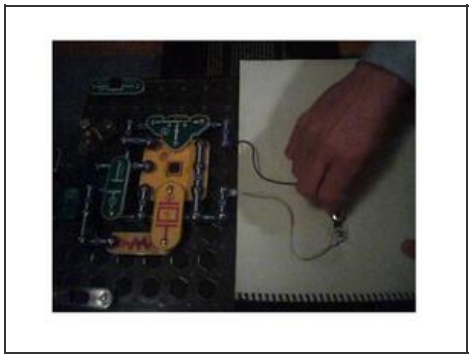
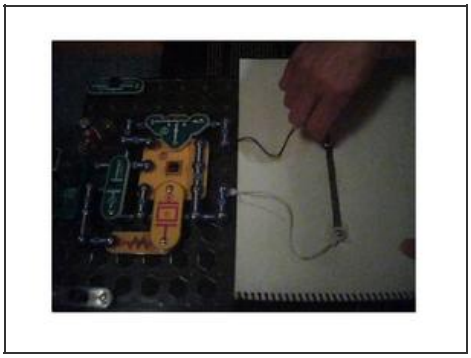
Step 8 — Introduction to Electronics: Resistance Is Futile





- If you will recall from my guide Introduction to Electronics: The Diode, you had to add a 100-ohm resistor into the circuit. Its purpose was to limit the current flowing through the LED to protect it.
- If you put too much current through an LED, it will burn out. With a POP! And sometimes pieces of plastic will fly off. And it will stink. Then you'll have to buy a new LED.
- Consider the water pipe analogy: when water flows through a pipe, the pipe offers very little resistance to the flow of water. If, however, a bunch of rocks are inserted into the pipe, this will increase the resistance against the flow of water through the pipe.
- As electrons flow through a wire or conductor, there is very little resistance to the electron flow.
- If you were to connect an LED directly to a battery without a current limiting resistor too much current will flow throught the LED and POP!
- Another way to think of it is filling a water balloon with a garden hose. If you put a kink in the hose this will limit the flow of water making it easy to fill the water balloon, but if you let go of the kink in the hose, the water balloon will fill too quickly and burst.

Step 9

- To get an idea of how resistance can affect a circuit, let's try a couple of experiments with the 555 tone generator circuit.
- In this first video, I replace the two-snap conductor--which has very little resistance--with the [a] 100-ohm resistor, [b] 1K-ohm resistor, [c] 5.1K-ohm resistor, [d] 10K-ohm resistor, and finally [e] 100K-ohm resistor. Listen to the change in sound as I replace each resistor.
- In this next video I used the 555 tone generator to create a pencil lead organ. I drew a thick bar on a piece of paper with a Number 2 pencil and I taped the white jumper wire to one end. Listen to the change in sound as the electrodes move across the pencil mark.
- If we compare the two videos it might be easier to figure out what is happening in the circuit. When the blue jumper wire is closest to the white jumper wire, the pitch is highest and when it is farthest away from the white jumper wire the pitch is lowest.
- In the first video when I replaced the two-snap conductor with the 100-ohm resistor, the pitch changed only very slightly. When I inserted the 1K-ohm resistor, the pitch got lower. With the 5.1K-ohm resistor the pitch got lower still and so on until the 100K-ohm which caused the pitch to be the lowest.
- We can then deduce that as resistance increases in the circuit, the pitch gets lower. Conversely, as resistance decreases, the pitch gets higher. Recall that we are changing the resistance on the circuit connected to pin 7 of the 555, which controls the timing of how quickly or how slowly the capacitor charges and discharges.
- As resistance increases the capacitor charges and discharges more slowly and the pitch gets lower. As resistance decreases the capacitor charges and discharges more quickly and the pitch gets higher.
- You may thus find this circuit useful for testing the relative resistance of different substances. Obviously it won't be as useful as a multimeter, but you have built a simple audio resistance tester.

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